Research, Development and Acquisition

Technology Initiatives in Support of Joint Warfighters — Current Initiatives

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The U.S. Army Space and Missile Defense Command is continuously exploring ways to better meet its ever-growing mission demands. In the last Army Space Journal, I discussed how SMDC delivers Space, and near Space, capability to the Army and the joint warfighter. This article explores current initiatives that will improve support to missile tracking and testing and Space launch efforts at the Ronald Reagan Ballistic Missile Defense Test Site (RTS)/U.S. Army Kwajalein Atoll (USAKA); support to the joint warfighter through use of near Space platforms to enhance situational awareness on the battlefield, modeling and simulation efforts to combine live testing elements where feasible with simulations, and Joint Tactical Ground Station (JTAGS) support to combatant commanders; and through the establishment of an Interceptor Center of Excellence (ICoE) and a partnership with the Air Force Research Laboratory.

Real-time mission data from the Pacific Rim possible through fiber optic cable

SMDC supports the Missile Defense Agency's (MDA) efforts to build a missile defense system through real-time mission support at RTS. Negotiations are under way to install a multi-million dollar submarine fiber optic cable that will enhance connectivity between RTS and its customers in the continental U.S. (CONUS) and points beyond. This capability is expected to be in place this year. From the remote and isolated Republic of the Marshall Islands (RMI), the cable would link USAKA with Guam, as well as the RMI — through the Federated States of Micronesia (FSM) — a distance of approximately 3,500 kilometers (2,170 miles).

Detailed planning and negotiations are under way for the Micronesia Cable System (MCS) installation. The project is a key element of USAKA's strategic vision to enhance customer support in the areas of theater and ballistic missile testing and Space operations. It is scheduled to be operational in CY05.

It directly complements the Department of Defense (DoD) and Army transformation efforts to create a secure, robust optical Internet Protocol terrestrial network — the Global Information Grid-Bandwidth Expansion, or GIG-BE. The MCS will be the first land line connection between USAKA and CONUS, providing real-time data transfer.

As the primary ground-based missile defense test site and an integral participant in ballistic missile defense development, RTS is critical to the MDA's efforts. This new high bandwidth connectivity will greatly benefit developmental testing of the ballistic missile defensive systems.

Future expanded intra-Pacific ballistic testing exercises will increasingly involve element and surrogate sensors and control distributed across multiple test ranges supporting tightly coordinated, concurrent operations.

To date, narrow communications pipes have limited coordination of real-time operations. Latency and available (satellite) bandwidth restrict the amount of real-time information that can be transmitted, particularly between the Kwajalein Atoll and CONUS. High bandwidth fiber connectivity would allow real-time information such as visualization and sensor-tracking displays to be transmitted directly to MDA and other CONUS locations, thereby increasing our ability to understand what is occurring across the largest testing operation area in the world.

This high bandwidth connection would speed distribution of mission data and provide analysis more quickly to users. The current narrow bandwidth causes a bottleneck, slowing the transmission of hundreds of gigabytes of critical data from RTS to the data analysis center in CONUS after a mission. This problem prevents RTS from applying lessons learned in one test to follow-on tests.

The FSM Telecommunications Corporation and the Marshall Islands National Telecommunications Agency are negotiating to purchase the MCS from Tyco Telecommunications, the system installer. Plans are to finance the project through the Rural Utility Services, an agency of the

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NASA's Helios is an example of a Heavier Than Air (HTA) platform

U.S. Department of Agriculture. Both the FSM and the RMI are anxious to acquire the fiber to their countries since they view it as important for business growth as well as for improving quality of life for their citizens.

DISA has agreed to be the primary negotiating agency for the U.S. government.

The MCS would allow a vast increase in operations for USAKA/RTS. Several organizations within the U.S. Pacific Command (PACOM) have already contacted USAKA about establishing remote UHF, VHS and HF communication sites. The U.S. Air Force has requested real-time display of all Space surveillance data and many customers in missile defense organizations would not have to send as many people to conduct tests at Kwajalein. The data from a BMDS test could be displayed real time anywhere in the world reducing the requirements to travel to USAKA for the actual test. These capabilities provide value added to the U.S. as the complexity of the Missile Defense system Testing will continue to increase.

USAKA/RTS Long Range Launch Vision

In addition to its missile tracking and testing mission, RTS also offers several unique features that are advantageous when considering locations for a Space launch complex and support of the DoD Operational Responsive Launch on Demand. Kwajalein Atoll is part of the Marshall Islands and is located in the West Central Pacific Ocean. It is 2,136 nautical miles (3,950 km) southwest of Honolulu. The atoll is 594 nm (1,100km) north of the equator in the latitude of Panama and the Southern Philippines Islands.

The most obvious advantage is certainly the near equatorial location at approximately 9° North latitude. This provides two advantages: 1) Space launches to the east realize significant benefits through capitalizing on the rotational velocity of the Earth. From the launch vehicle standpoint, this translates to a significant increase in payload capacity to orbit versus CONUS launch sites (a 150 fps gain). 2) Space launches into geosynchronous orbit, the most significant commercial orbit, require a smaller plane change (from 9 degrees to equator) than other launch sites. Compared to Cape Canaveral, Fla., 20 percent less velocity is required (4500 fps vs. 5500 fps by simultaneous orbit circularization).

There are no U.S.-based equatorial launch sites from which Space launch customers can conduct launches. Although Low Earth Orbits (LEO) with low inclinations can be achieved from Cape Canaveral, launching from this location requires an extremely inefficient dogleg maneuver which reduces the payload and increases the fuel requirements. The other possible U.S. equatorial launch location is the Boeing "Sea Launch" platform. Although this allows launches to be conducted from the equator, there are limited logistical and instrumentation assets available for these operations. Sea Launch is a very expensive launch operation since it comes with a large crew and requires extensive long-range logistical support. The last alternative is launching from foreign locations. French Guiana has an equatorial launch location. This can be an expensive option in addition to issues with classified payloads. This presents a significant obstacle to many payload providers due to legal, security and technology transfer concerns that significantly limit the ability to launch U.S. payloads on foreign launch vehicles. As a result, virtually all U.S.-built payloads are launched from the CONUS-based Space ports and employ extremely costly and inefficient dogleg trajectories to achieve low inclination orbits. Due to the unique status of Kwajalein, the potential exists to provide a near equatorial launch site for a U.S. launch vehicle provider while avoiding export considerations.

Initial analysis shows that orbits can be achieved over 80 percent of the world's land mass from RTS. This could be a significant issue when developing a concept of operations (CONOPS) for the DoD operational responsive launch operations. Under this concept, multiple boosters and payloads would be pre-positioned at USAKA. Different trajectories would be developed for each contingency. If a strategic need arises, entire new constellations could be launched to achieve needed satellite coverage.

Another significant advantage enjoyed by Kwajalein is the potential to fly a wide variety of trajectories and launch azimuths as a result of the extraordinary low population density in the RMI. This is the same advantage that has resulted in the U.S. using Kwajalein as its primary ballistic missile test site for more than 40 years. The total land area of the RMI is only 70 square miles and thus it is rela-

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tively difficult to endanger personnel and property through an errant missile.

The upper level winds on Kwajalein are, based on the data of the Range Reference Atmosphere, lower than other CONUS-based Space ports. At 14 km altitude (typically the worst case wind), the 3-sigma value for Kwajalein is ~35 m/sec, while the Cape has 90 m/sec and VAFB ~75 m/sec (winds in E-W direction for the worst case month)

A closely related advantage, again a result of the RMI consisting primarily of deep ocean area, is the relative ease of addressing environmental and historical concerns. While environmental and historical concerns must still be addressed at Kwajalein, there is relatively little land area to be considered in terms of missile debris. Most launch vehicle contractors have encountered the stringent regulations associated with CONUS operation and would realize significant operational savings at Kwajalein.

Another factor, undoubtedly little understood by potential customers, is the advantage of collocating a Space launch facility at the range. Operations at Kwajalein enjoy the advantages of minimal safety, security and environmental constraints with high levels of radio frequency isolation. The suite of instrumentation available at Kwajalein is unparalleled in the world with significant wideband connectivity to CONUS locations via DS3 and fiber. This offers the potential to provide a level of "diagnostic" information unavailable at any other launch facility in the world. This can be particularly important for relatively immature launch vehicles that are likely to experience flight anomalies.

An additional factor related to collocation with the range is the nature of the community at Kwajalein. The entire Kwajalein community is focused on missile test and associated support. The level of experience and expertise is the highest in the world and provides a tremendous pool of talent to assist the launch vehicle and payload personnel in addressing any issues associated with their operations.

The Kwajalein community is also very comfortable with a wide variety of missile flight test operations and thus there is little likelihood of community resistance to introduction of a new launch vehicle, as one would expect to encounter at some other launch sites. Typical expenses associated with community outreach, town hall meetings, local permitting, etc., would largely be eliminated at Kwajalein.

The USAKA/RTS equatorial location, unparalleled instrumentation and extensive logistical infrastructure offer a major advantage for a Space launch complex and support to DoD's Operational Responsive Launch on Demand.

Near Space Missions and Platforms

The Army Future Force will rely heavily on the technological advances needed for understanding and managing the battlespace environment. The platforms operating in the Near Space Region can support the warfighter in achieving the tenets of Army operations – initiative, agility, depth, synchronization and versatility.

Near Space is classified as the atmospheric region between 20 km. (12.4 miles) and 100 km. (62 miles). In the past three years, the Near Space Region has been gaining interest by DoD and the National Aeronautics and Space Administration (NASA).

For platforms positioned at an altitude of 60,000 feet, the line of sight (LOS) to the horizon is 300 miles and at 100,000 feet, the LOS to the horizon is 389 miles providing the battlefield commander with an extended view of the battlefield. Capable of deploying with various payload configurations, a wide range of mission areas could be supported to include intelligence, Wide Area Surveil

lance (WAS), reconnaissance, psychological warfare, communication relay, Space control and blue force tracking just to name a few. The Training and Doctrine Command has identified numerous capability gaps that Near Space technologies could support. Below is list of some of these capability gaps and Future Force requirements:

1) Enhanced Soldier Protection (in Full Spectrum Operations) through improved situational understanding
2) Modular, Scalable and Tailorable Battle Command and Control for Future Force utilizing optimized bandwidth
3) Enhanced Platform/Group Protection by providing continuous situational awareness
4) Dynamic, Uninterrupted C4 Architecture providing C2 of the battlespace over extended ranges
5) Enhanced Intelligence, Surveillance and Reconnaissance Capabilities providing actionable information through sensor fusion
6) Ability to Train the Force How and As it Fights through modeling and simulation training

Potentially there are many different platforms that operate in Near Space. These include Lighter Than Air (LTA) and Heavier Than Air (HTA) platforms. There are advantages and disadvantages with both types of platforms. The tables below list the advantages and disadvantages of LTA and HTA platforms.

HTA platforms include aircraft and Unmanned Aerial Vehicles (UAV). Currently, the joint Global Hawk program, Air Force's U-2 aircraft and NASA's Helios are examples of HTA platforms.

Near Space DoD LTA platforms include High Altitude Airships (HAA) and ultra high free floating balloons. Currently, NASA and Air Force Research Laboratory fly free floating balloons.

In regard to the high altitude airship concepts, there are two major activities. 1) a joint Advanced Concept Technology Demonstration (ACTD) and 2) the Defense Advanced Research Projects Agency (DARPA) Integrate Sensor Is the Structure (ISIS) program. The objective of the HAA ACTD is to demonstrate the engineering feasibility and potential military utility of an unmanned, untethered, gas-filled, solar-powered airship that can fly at 60,000 feet. The prototype airship will be capable of continuous flight for up to a month while carrying a payload weight of 500 pounds and payload power is 3kW. The ACTD is intended as a developmental step toward an objective HAA that can self-deploy from CONUS to worldwide locations and remain on station in a geo-stationary position for a year or more with a payload weight of 4,000 pounds and payload power of 65kW.

The ISIS program integrates a powerful radar into the structure of an airship. The radar provides Ground Moving Target Indicator, Air Moving Target Indicator and a communication relay. With a very large aperture, ISIS provides a much needed capability at a fraction of the cost of satellites.

Operating in the Near Space Region offers the warfighter many capabilities that are limited or non-existent today. Near Space operations will improve missions in the areas of intelligence, WAS, reconnaissance, psychological warfare, communication relay, Space control and blue force tracking at a fraction of the cost.

Modeling and Simulation

SMDC is conducting a feasibility study to see if we can contribute to a live-virtual simulation and testing capability for the Ballistic Missile Defense System (BMDS). The command is looking to make contributions to the BMDS life cycle by assisting with developmental testing, operational testing, mission planning and training. The command would align its approach with the MDA modeling and simulation architecture. The capability would permit test and training activities combining live elements where feasible with simulations for those elements that are too costly (e.g. target and interceptor launches) or not yet available (e.g. "what if" analysis for new deployments or developments). An end-to-end test using simulated portions can provide confident assessments of overall system effectiveness before more costly acquisition commitments, and can provide more effective training and human factors understanding during and after acquisition.

As examples, the capability would be able to:

- Evaluate the effectiveness of proposed sensor systems, before construction and deployment
- Conduct "live" tests of communications and control systems, using simulated sensor input to drive the test
- Conduct training operations, much as the command-and-control tests above to exercise in the face of simulated foreign-based attack.

If the concept materializes, it is possible that multiple SMDC sites could have a hand in contributing to BMDS. The concept is anticipated to support MDA's Joint National Integration Center, located in Colorado Springs, Colo., which provides ballistic missile and theater air defense training and testing capabilities.

Joint Tactical Ground Station (JTAGS)

In the field since 1997, the Joint Tactical Ground Station (JTAGS) provides combatant commanders an in-theater capability to receive, process and disseminate ballistic missile warning information from raw infrared data (IR) obtained by the Defense Support Program (DSP) satellites. The JTAGS is forward deployed and supporting three theaters today, providing combatant commanders the unique capability to receive in-theater, via direct down link, the DSP data. Once received, the JTAGS computes tactical ballistic missile (TBM) track data and

launch and impact point estimates. It then disseminates warning and cueing information via existing tactical and strategic joint communication networks. Given the short time lines associated with the missile warning challenge, combatant commanders have identified JTAGS as a critical element in providing force protection and support to combat operations. In addition to supporting theater missile warning, JTAGS also supports the warfighter's ability to visualize the entire joint fight by reporting on battlespace characterization type IR events throughout the theater. Prior to the commencement of hostilities and continuing on, JTAGS was and remains a key piece of Operation Iraqi Freedom force protection efforts. SMDC/ARSTRAT's 1st Space Brigade, headquartered at Peterson Air Force Base, Colo., operates and provides command and control of the five JTAGS systems in the Army inventory. JTAGS is a jointly manned system with support from the U.S. Navy and integrated into the overarching Ballistic Missile Defense System (BMDS).

JTAGS is one of three components of U.S. Strategic Command's (USSTRATCOM) Theater Event System (TES) Architecture. As a part of this critical architecture, JTAGS is required to maintain a viable capability similar to the fixed site elements of the architecture. This allows it to maintain a robust, operational posture that supports USSTRATCOM's challenging missile warning mission.

In conjunction with the Space Based Infrared System (SBIRS) satellites fielding, the JTAGS will be replaced by JTAGS Multi-Mission Mobile Processor (M3P) in the 2012 time frame. The product improvements afforded by SBIRS/JTAGS M3P will greatly expand the threat target set, provide a faster reporting and processing capability, and thereby, significantly improve situational awareness from both a missile warning (tactical and strategic) and battlespace characterization perspective. The JTAGS M3P's Net Ready communication requirements will enhance its joint communications architecture connectivity, ensuring it can disseminate critical data, in a timely manner, to a wide reaching group of users. The JTAGS M3P will continue along the path of JTAGS as a key component of the TES architecture and is also expected to support USSTRATCOM's critical strategic missile warning mission.

Focused on today's missile warning efforts and postured to address tomorrow's evolving threats, JTAGS and JTAGS M3P are key elements in addressing the tactical and strategic missile warning challenges; and in developing the operational threat picture facing today's and future warfighters.

Interceptor Center of Excellence

SMDC is honored that a cutting-edge organization such as the Missile Defense Agency (MDA) acknowledges the past contributions and current key competencies of SMDC by establishing the Interceptor Center of Excellence (ICoE) under SMDC's Research, Development and Acquisition arm in Huntsville, Ala.

The purpose of the ICoE is to develop and apply advanced technology to ballistic missile defense (BMD) enterprise-wide interceptor development, integration and overall performance challenges. The ICoE will gather experts and the key interceptor programs they manage in one location to better enable rapid transfer of knowledge and developing technologies among MDA interceptor programs.

The close proximity of the ICoE to major BMD system elements such as Ground-Based Midcourse Defense and Terminal High Altitude Area Defense will speed development and transition of subsystems and components to improve capability and/or lower cost of the recipient program. Members of the ICoE and MDA will work closely together to enable rapid analysis of new system concepts leading to ICoE design, development, and demonstration of the most promising new interceptor systems. This will accelerate fielding of Block upgrades, while minimizing development costs.

SMDC is optimistic that this strategic partnership formed with MDA will prove beneficial as the BMD system evolves through incorporation of advanced interceptor products developed by the Interceptor Center of Excellence.

AFRL and NASA Cooperation

COL Jack Tuder is a member of the RDA/Integrated Capability Management (ICM) staff serving as the Air Force Research Laboratory (AFRL) Commander's Representative in Huntsville, Ala. He brings Air Force, NASA and international experience in acquisition and developmental engineering, in addition to command and control operations. His primary focus is on common Space and missile technology synergisms, for all phases of intercept, being developed by the services.

An example of such technology is the Early Launch, Detection and Tracking (ELDT) technologies applicable to the boost phase of intercept. These technologies include the development of passive radar reception and hyper-temporal imaging (HTI). ELDT is being developed by the Missile Defense Agency (MDA) and executed by AFRL. The concept uses RF energy generated by over the horizon radar with passive receivers to gain early detections of launched missiles. The Australian Ministry of Defense, who has signed a missile defense partnership memorandum of understating (MOU) with MDA, is a leader in the use of this type technology and serves as an indicator of other similar international interests. HTI technology is showing promising results in the most stressing ELDT environment. It's intended to detect missile plume photons reflected through cloud cover in a daylight environment, thus indicating the detection and location of a possible launch.

Jack also supports SMDC/RDA in finding synergisms with NASA's Marshall Space Flight Center (MSFC). SMDC's interest in developing keen technology applicable to "Warfighter" uses in missile defense technology is reflected by its dialogue with organizations such as MSFC. Located next door to SMDC, MSFC has common aerospace technology objectives in areas such as "low cost" launch, thermal protection systems and non-volatile memory for control systems. All of these technology requirements are common to the services for taking the "high ground" and at the same time, Space exploration.